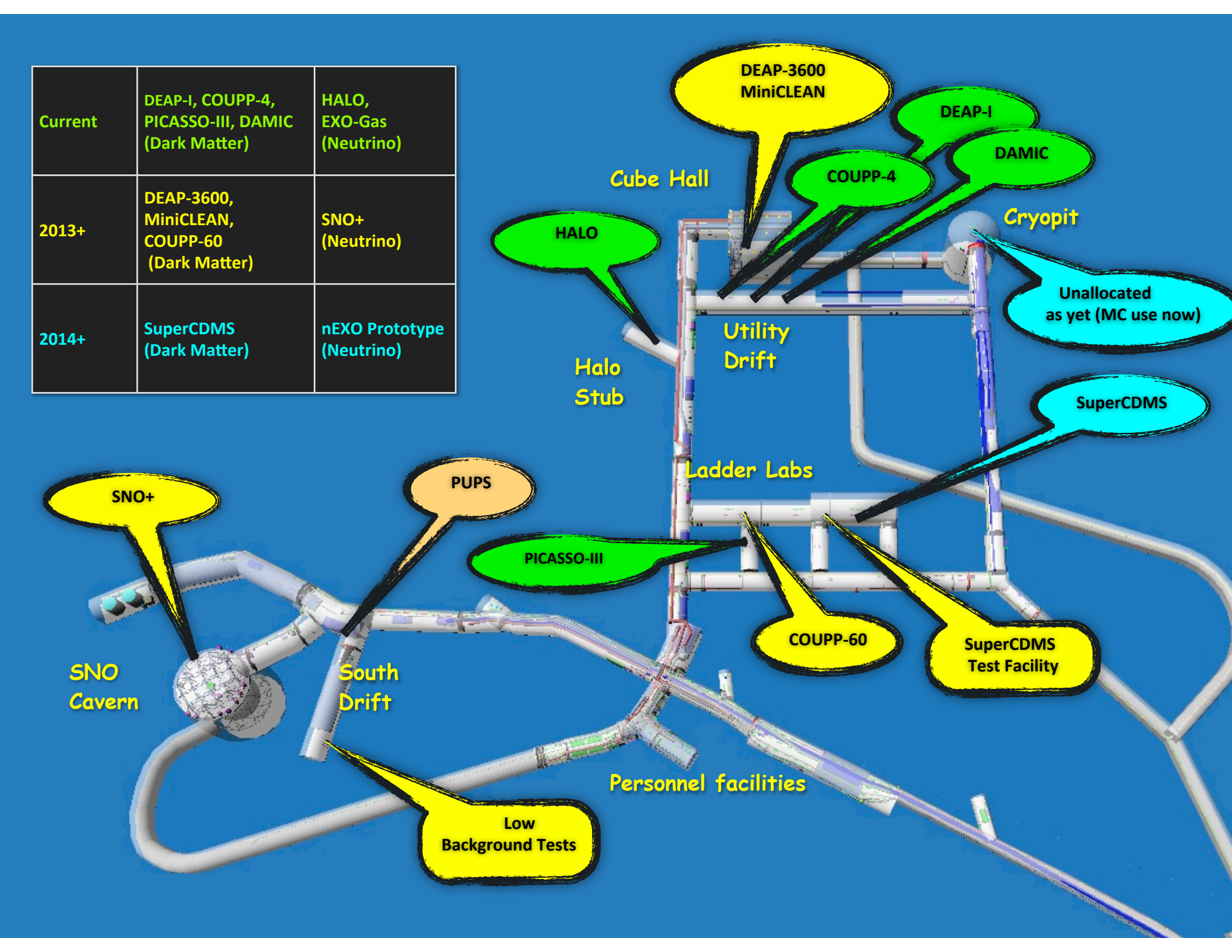
SNOWMASS SNOLAB Notes

- Status Quo
- Additional Developments: Experiments
- Additional Developments: Facility

Current	DEAP-I, COUPP-4, PICASSO-III, DAMIC (Dark Matter)	HALO, EXO-Gas (Neutrino)
2013+	DEAP-3600, MiniCLEAN, COUPP-60 (Dark Matter)	SNO+ (Neutrino)
2014+	SuperCDMS (Dark Matter)	nEXO Prototype (Neutrino)



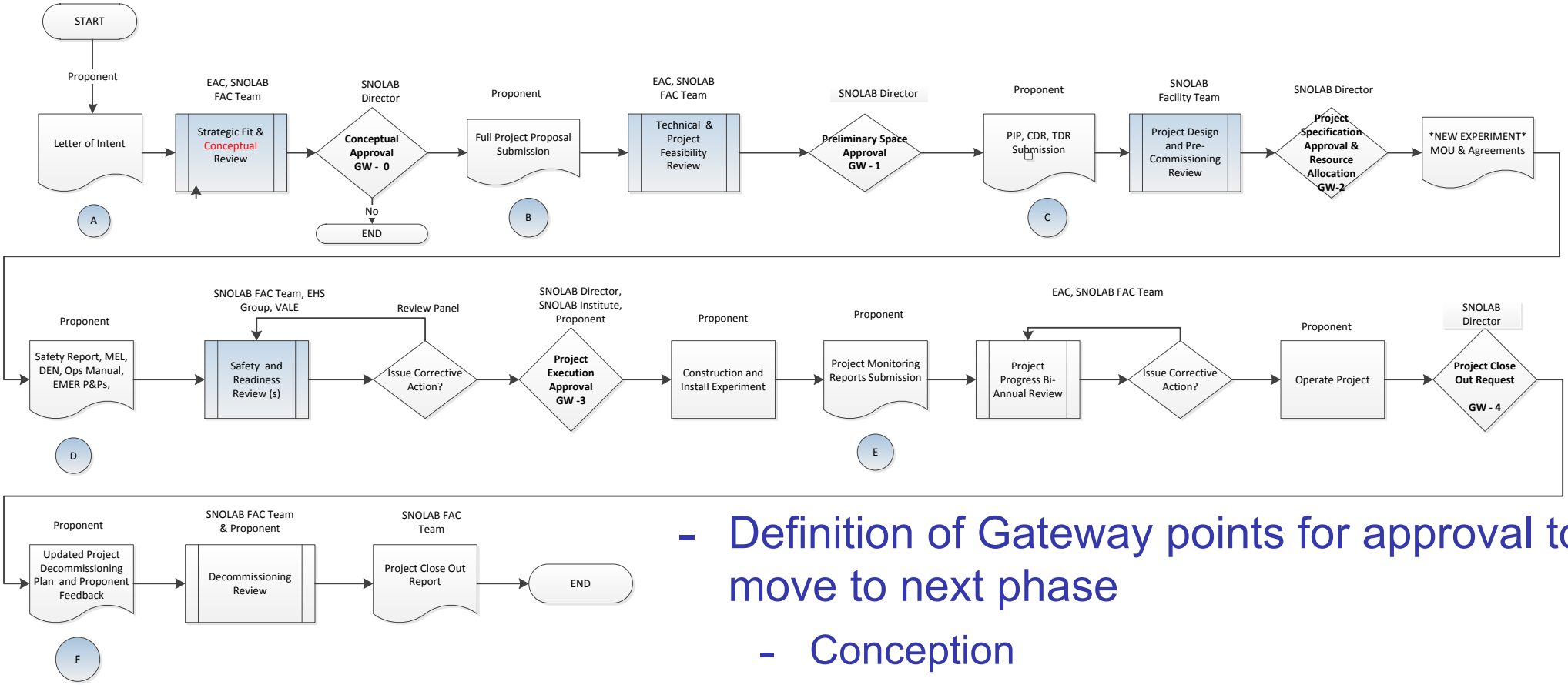
SNOLAB operational model

- For current facilities
  - Traditional NP “free-at-the-point-of-access” model
  - Canadian support for baseline operations of the facility, including life safety, power, ventilation, materials handling, compressed air, UPW, IT and networking
  - Experiments charged for additional ‘non-standard’ costs: significant transport, high power usage, significant gas/nitrogen
  - Experiments responsible for clean-room beyond C2000
  - Infrastructure negotiated: capital expected from experiments
- Based on current planned programme
  - If additional experiments incorporated immediately then additional installation and construction support would be required through the experiment for infrastructure

Facility Access

- Experiment life-cycle mapping
  - Provides visible pathways for review and ‘gateway’ approvals
  - Development of ‘project implementation plans’
- Programme oversight by international EAC
  - Full bi-annual programme review - operational and requests
  - Advisory to SNOLAB Director
  - Input from project implementation plans
- Facility access merit based
  - Letter of Interest, reviewed by EAC
  - International facility, as per initial awarding mechanism
    - Demonstrated by COUPP, miniCLEAN, SuperCDMS, DAMIC

Experiment Life-cycle Map



- Definition of Gateway points for approval to move to next phase
  - Conception
  - Feasibility
  - Execution
  - Operation
  - Close-out

LEGEND of PROJECT PHASES:
A – Conception
B - Feasibility
C – Development
D – Execution
E – Operation
F - Closing

SNOLAB EXPERIMENT LIFE CYCLE (2011-09-22) REV 05

Additional Development - Experiments

- Existing Space will become available as projects complete
  - "J" drift anticipated for R&D/rapid deployment at all times
  - Ladder labs:
    - SuperCDMS area committed; COUPP/PICASSO for next five years
  - Cube Hall: argon programme for next five years
  - SNO+ cavity: occupation over next decade
  - Cryopit: process underway to select project:
    - presume commit in 2015; for a decade
  - From 2020 Anticipate new experiments in Cryopit and Cube Hall
- Planned projects
  - No formal commitment made yet, but several projects presented to Cryopit review in 2011
  - DEAP-CLEAN, EXO, GeoDM, COUPP, PICASSO, 1TGe
  - This process continues this year

Additional Development - Experiments

- Selection process for experiments as now
  - Purely merit based
  - Fully international
  - U.S. projects (as now) extremely welcomed
- Scope of programme
  - Anticipated programme revolves around G2 and beyond for DM; $0\nu\beta\beta$
  - Additional science strands in progress: geotech/mining; subsurface life
  - No requests for long baseline neutrino targets, nor proton decay
    - These are not excluded *per se*
    - Design work has not been completed for megatonne detectors

Additional development - Facilities

- Is there scope for additional development at SNOLAB, either 6800' or elsewhere?
  - Yes, but the current strategic plan assumed no immediate development for the next 4 years at least
  - This does not preclude such happening; just that funding requires dialogue with all interested parties
  - Vale have already indicated willingness to discuss
- Non-technical issues
  - Funding sources and agreements
  - Operational model agreements
  - Agreement with Vale on development scope

Technical Requirements

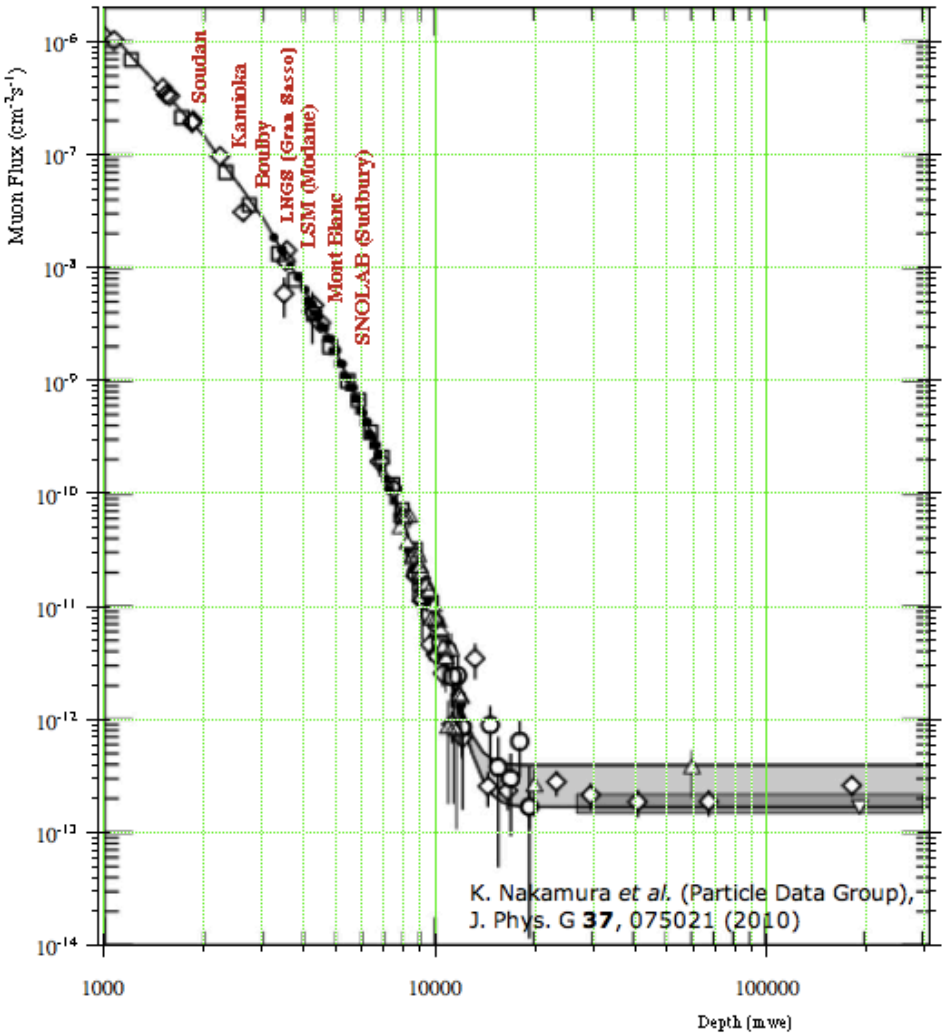
- Where?
  - 6800' exploits current infrastructure, but requires management of development not to impact current facility and projects
  - Other level? Access to lower levels possible, support infrastructure in place from Vale
  - Further geotechnical studies needed to define capability. Larger cavities had not been investigated and modelled in current facility, but rock mass is well understood and stable hanging wall
- Connection to current clean room
  - Requires separation and will impact current ops
  - SNOLAB was developed with SNO operational
  - Lost time ~5 days, most planned power transitions
- Ventilation and power upgrades?
  - Separation of facilities incur additional costs

Additional development

- Timeline?
  - Driven by experiment need - when are these cavities needed?
  - Components required: negotiation, geo-tech, design, excavation, outfitting
  - Historical: Overall SNOLAB development was six years from start to completion, but experiment deployment during this time occurred.
    - 4 years excavation, 2 years outfitting concurrent, 2 years to clean room concurrent
- Cost?
  - Historical validated costs for SNOLAB experimental volume (i.e. to clean room status): ~$3k/m3
  - Scaling may not be linear if constraints imposed by access through shaft or total underground workforce, or through economy of volumetric scaling

When is ‘deep enough’?

- Current generation experiments well served by current facilities and backgrounds achievable
- Additional shielding available from c.r’s
  - Three orders magnitude suppression from current deepest labs
  - Limited by muons from neutrino production
- If 3G++ systems require greater depth then challenge for facilities
  - But not unsurmountable

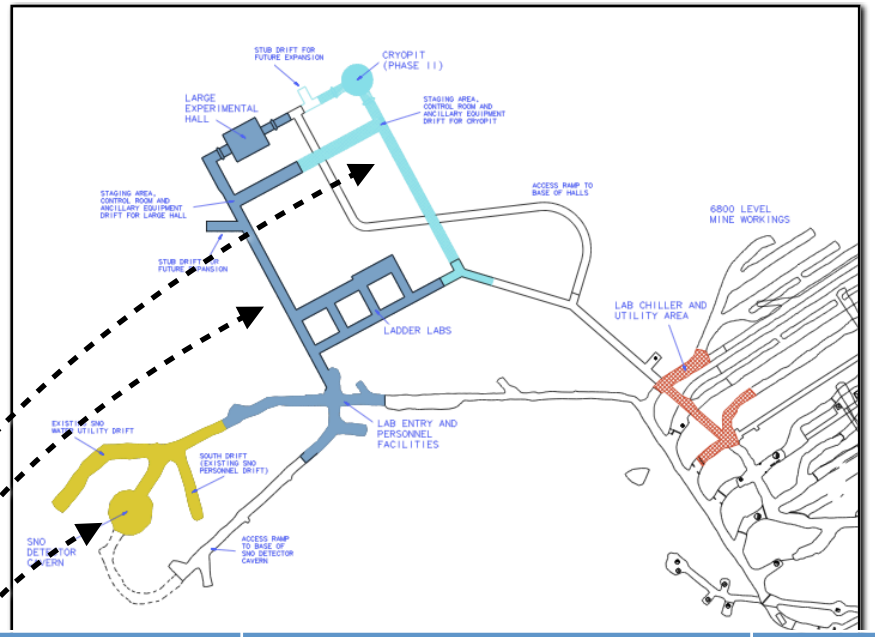


Back-up Slides

SNOLAB Strategic Mission

- Developed within Strategic Plan 2012-2017
- Enable world-class science to be performed at SNOLAB by national and international experimental collaborations, providing scientific underpin, technical skills and knowledge, generating and developing international connections, and through development of a strong reputation; SNOLAB will also provide risk mitigation, reacting quickly to challenges/crises to enable the efficient execution of the scientific programme
- Spearhead world-class science at SNOLAB through its own research group as part of the international and national community, developing synergies with other groups worldwide;
- Catalyse world-class science at SNOLAB by providing a sought after collaborator in its own right and through providing transformational opportunities for collaboration and knowledge exchange to other groups through workshops, external connections and local interactions;
- Promote world-class science and societal benefits through a strong public and professional outreach programme, and through technical knowledge development and transfer;
- Inspire the next generation of innovators through strong educational outreach, knowledge transfer and the training of highly qualified personnel;

SNOLAB Space Summary



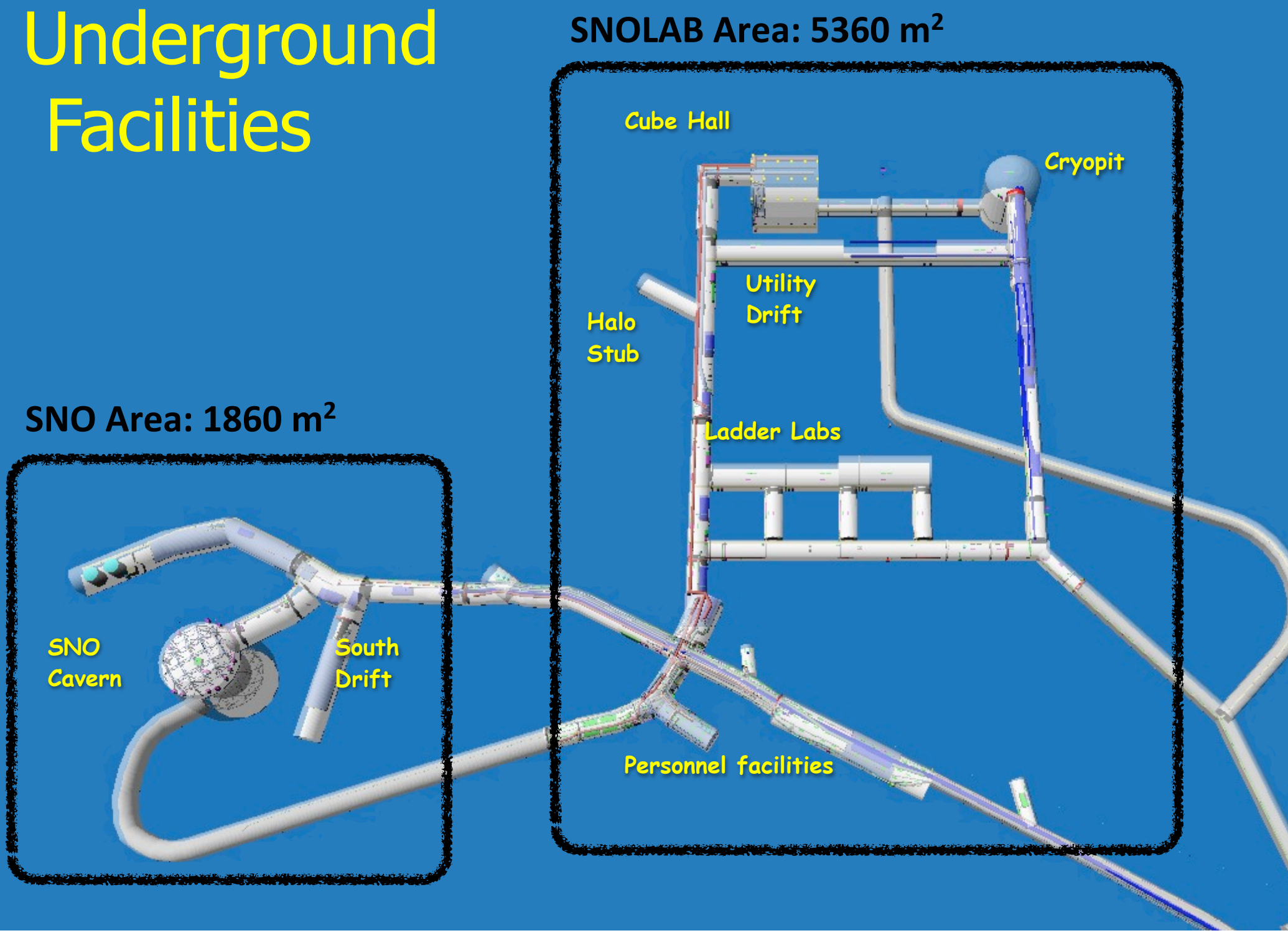
Area	Dimensions	Area	Volume
SNO Cavern	24m (dia) x 30m(h)	250m^2	9,400 m^3
Ladder Labs	32m(l)x6m(w)x5.5m(h)	190m^2	960 m^3
	23m(l)x7.5m(w)x7.6m(h)	170m^2	1,100 m^3
Cube Hall	18.3m(l)x15m(w) x 19.7m(h)	280m^2	5,600 m^3
Cryopit	15m(dia) x 19.7m(h)	180m^2	3,900 m^3

	Excavation		Clean Room		Laboratory	
	Area (m2)	Volume (m3)	Area (m2)	Volume (m3)	Area (m2)	Volume (m3)
Original SNO Areas	1860	16500	1130	13300	750	11700
+Phase I	6070	38750	3900	29750	2430	23700
+Phase II	7220	46650	4940	37250	3060	29550

The SNOLAB Science Programme

Experiment	Solar ν	0νββ	Dark Matter	Supernova ν	Geo ν	Other	Space allocated	Status
SNO+	√	√		√	√		SNO Cavern	Construction
PICASSO-III			√				Ladders Labs	Operational
DEAP-1			√				J'-Drift	Operational
DEAP-3600			√				Cube Hall	Construction
MiniCLEAN			√				Cube Hall	Construction
HALO				√			Halo Stub	Operational
PUPS						Seismicity	Various	Completed
SuperCDMS			√				Ladder Labs	Request
EXO-gas		√					Ladder Labs	Request
COUPP			√				Ladder Labs	Operational
DAMIC			√				Ladder Labs	Operational
COBRA		√					Ladder Labs	Request

Underground Facilities



Facility Services

- Ventilation
  - 100,000 cfm mine air flow to laboratory, mainly used for cooling of chillers
  - 10% make-up air fed in lab - 13 air handling units in lab
  - Maintains pressure differentials for cleanliness
  - 10 air changes/hour nominal; 5 air changes/hour in cavities
- Cooling
  - 1 MW cooling capability from 5 cooled water units delivering 10˚C water to the laboratory. 100kW from rock in steady state (42˚C base)
  - 20% utilised at present with minimal expt. load
- Power distribution
  - 3-phase 13.8 kV fed to facility
  - Stepped to 3-phase 600V (total 2000 kVA)
  - 150kW (++?) Generator planned
- Water
  - Utility water derived from mine water
  - UPW as a general capability for experiments (150l/min 183 kΩm)
  - Waste disposal through mine systems (except sewage - STP)

Experiment design considerations

- Transport
  - Cage size: 3.7 m x 1.5 m x 2.6 m, slinging for larger objects
- Seismic mitigation
  - Design criteria now 4.3 Nuttli, following 4.1 event in SNO
  - Forcing function applied to experiment designs - maximum velocity 800 mm/s at 5 Hz
- Pressure
  - Air pressure is 25% higher than atmospheric
  - Excursions during ventilation changes and crown blasts (up to 3% seen)
    - managed through baffling and blast doors
    - design pressure for experiments up to 20 psi
- Radon (~130 Bq/m3)
  - No direct radon suppression in air intakes
  - Cover gas used (LN2 boil-off) on detector systems
  - Ventilation (make-up vs recirculation) minimises radon emission from walls
- H2S
  - Long term exposure to mine air showed deposition of CuS on SNO electronics
  - Suppression is now installed in the air handling units

SNOLAB Funding

- Capital investment was $85M in SNO and $65M in SNOLAB; Operations are ~$8M/year cash; SNOLAB experiments derive their own additional funding outside this capital envelope
- Additional capital requires new proposals (e.g. NOHFC underway)
- Support for facility operations have been derived from Provincial, Federal, University and industrial partners; Significant in-kind support has been provided by Vale
- SNOLAB operational funding secured to 2017, does not include research support (i.e. experiment capital, students) and requires mid-term reviews of science:

Funding Source	Period	Amount ($k)
CFI MSI (Federal)	FY2012/13 - FY2016/17	22,600
MEDI (Ontario)	FY2013/14 – FY2016/17	17,100
MEDI ORF-RE (Ontario)	FY2007/08 – FY2012/13	12,600
Vale in-kind support	Annual	8,000
University (ineligibles)	FY2012/13	360

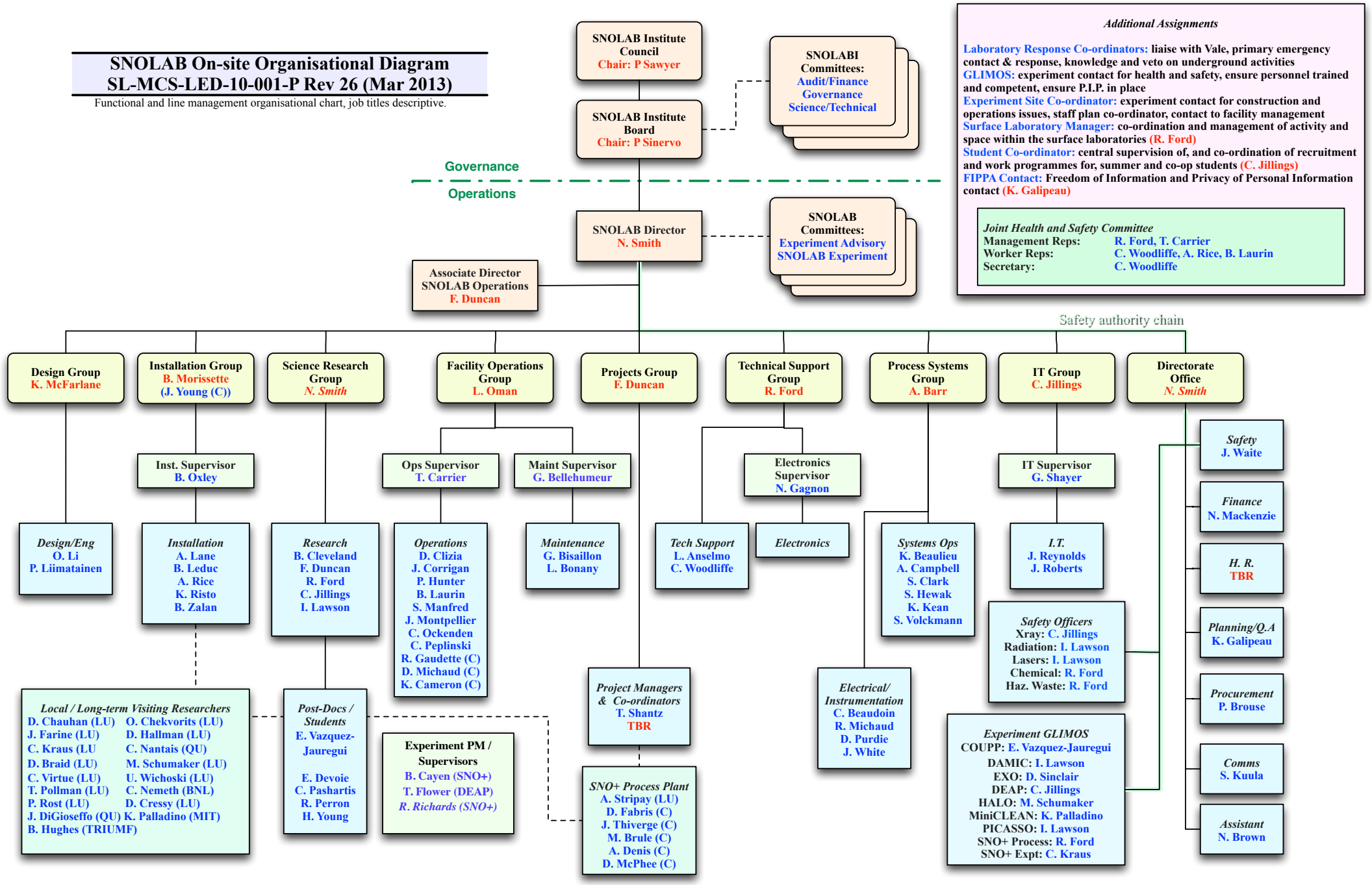
SNOLAB Core Competencies

- Total staff complement is ~60
- Operations and maintenance account for the majority of these
  - Significant ‘impulse’ of projects in deployment at the moment
  - Resources stretched
- Research Scientists (6 staff)
  - Act as full collaborators, TRIUMF and IPP as the model
  - Provide interface between projects and SNOLAB
- Engineering staff (3 staff)
  - Focus is on the SNOLAB specific components (seismic, depth, etc)
  - Provides support during initial design phase of projects
- Installation groups (6 staff)
  - Take lead in deployment of projects

Current OrgChart

SNOLAB On-site Organisational Diagram
SL-MCS-LED-10-001-P Rev 26 (Mar 2013)

Functional and line management organisational chart, job titles descriptive.



Additional Assignments

Laboratory Response Co-ordinators: liaise with Vale, primary emergency contact & response, knowledge and veto on underground activities

GLIMOS: experiment contact for health and safety, ensure personnel trained and competent, ensure P.I.P. in place

Experiment Site Co-ordinator: experiment contact for construction and operations issues, staff plan co-ordinator, contact to facility management

Surface Laboratory Manager: co-ordination and management of activity and space within the surface laboratories (R. Ford)

Student Co-ordinator: central supervision of, and co-ordination of recruitment and work programmes for, summer and co-op students (C. Jillings)

FIPPA Contact: Freedom of Information and Privacy of Personal Information contact (K. Galipeau)

Joint Health and Safety Committee

Management Reps:	R. Ford, T. Carrier
Worker Reps:	C. Woodliffe, A. Rice, B. Laurin
Secretary:	C. Woodliffe

Support for Experiments

- Provides technical and administrative support to SNOLAB experiments:
  - design, construction, operations
  - background assay, science support
  - materials transport, cleaning, EH&S, training, procurement
- The Research team members can act as collaborators on experiments, providing operational and scientific support
- Infrastructure support is provided through development of shielding systems, mechanical supports, access, EH&S, etc.
- Services provided as standard to experiments includes life safety, power, ventilation, compressed air, ultra-pure water, liquid nitrogen, IT and networking
- Vale provide materials transport through the shaft, maintain the safety of the infrastructure, regulatory checks, etc.
  - SNOLAB currently has ~50 people underground regularly, 3 dedicated cages
  - Cages integrated into Vale operations effectively (eg SNO D2O movement)